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PALEOBOTANY.—*Temperate species in the Eocene flora of the southeastern United States.*[1]

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The Eocene flora of the southeastern United States, collected from sediments deposited along the ancient, coastal margin of the land, has been interpreted as a subtropical, chiefly strand, lagoon, and bayou flora. This conclusion is inferred from the character of its composition, which included types of ferns, palms, and dicotyledons, whose living counterparts or relatives are adapted to life at or near sea level in the tropics and subtropics. Roughly 80 per cent of the dicotyledons had leaves with entire margins, confirming, according to the Bailey and Sinnott (1915) formula, the interpretation based on composition. "There is not a single strictly temperate type in the whole assemblage," says Berry (1916, p. 136), "the nearest approach to such types being the genera *Juglans*, *Myrica*, *Magnolia*, *Cercis*, *Ilex*, *Nyssa*, and *Fraxinus*.

The purpose of this paper is not to dispute the general conclusion just stated but to call attention to some specimens that I believe have hitherto been misidentified and that may have originated from trees growing under temperate conditions inland from the coast, perhaps along streams in the foothills of the Eocene Appalachians. These relatively rare specimens include species of *Fagus*, *Sassafras*, and *Staphylea*. Other genera, with temperate rather than subtropical implications, are listed in the Eocene column of Table 7 in Cain's (1943) paper discussing the Tertiary aspect of the present temperate forests of the Great Smoky Mountains National Park. Many of these genera are represented only by fragmentary leaves, fruits, or seeds, and their identifications at best are largely conjectural. Of *Salix*, *Quercus* (except *Dryophyllum*), *Celtis*, and *Platanus* (of the *occidentalis* type) I find no authentic fossil record, and the leaf called *Cercis wilcoxiana* Berry represents *Cercidiphyllum arcticum* (Heer) Brown. The presence of *Cladrastis*, *Prunus*, *Ilex*, *Aralia*, and *Cornus* is, it seems to me, based on specimens that need further confirmation before they can be cited as reliable evidence of the existence of those genera in the Eocene flora of the southeastern States.

Despite these criticisms all the temperate genera listed by Cain were most likely present in the Eocene inland and upland forest. Their absence from the fossil record may be explained by their having lived on sites unfavorable to the preservation of their remains, and to the destruction of such remains before reaching suitable sedimentary basins near the coast. Even so, an occasional fortunate accident may have preserved a leaf or a seed that now awaits discovery by more thorough search of the fossil-bearing strata.

Whether a Tertiary flora may be adjudged subtropical or temperate depends upon a sane application of the assumption that, in general, Tertiary species had habitat and climatic requirements similar or nearly similar to their modern equivalents. The critical point here, of course, is the accurate determination of the existing equivalents, if any; for, even if fossils are correctly identified generically, the misidentification of their specific living equivalents may lead to erroneous conclusions as to habitat and climate. The modern North

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American correlatives of the fossil species about to be treated are wide-ranging in the temperate zone, but none reaches the Tropic of Cancer except species of *Acer*, *Carpinus*, and *Staphylea* at moderate to high altitudes in Mexico and Central America. These, however, can hardly be called indicative or representative of a subtropical climate in the ordinary sense.

In a previous paper (Brown, 1940, p. 351) I discussed *Acer knowltoni* (Berry) Brown from Eocene deposits near Somerville, Fayette County, Tenn. This maple is represented by asymmetric leaflets and characteristic samaras, which suggest comparison with the living boxelder maple, *Acer negundo* Linnaeus. Moreover, these fossils are associated with those hereinafter described as *Staphylea splendens* (Berry) Brown just as their living counterparts may be found associated today, thus strengthening the conviction that a maple of the *negundo* type is correctly identified as present in that Eocene flora. The absence of authentic Salicaceae and Betulaceae from the Eocene floras of the southeastern States would seem inexplicable if other predominantly temperate genera like *Acer*, *Sassafras*, and *Staphylea* were present. In 1942, however, in a collection made by F. S. MacNeil, of the U. S. Geological Survey, on the Taylor farm, Chester County, Tenn., I found well-preserved portions of betulaceous leaves having the pinnate secondary venation and the doubly serrate or serrulate margin characteristic of most Betulaceae. Examples of other missing temperate genera will doubtless be found as collectors become aware of the possibilities.

Fagus aspera (Berry) Brown, n. comb.

Diospyros asper Berry, U. S. Geol. Survey Prof. Paper 156: 127, pl. 25, fig. 32. 1930.

In 1937 I found several more specimens of the kind described by Berry as calyces of *Diospyros asper* at the same locality on Mill Creek, Hardeman County, Tenn. These fossils received the specific name *asper* because their outer surface is conspicuously roughened by pointed, short prickles or papillae. Although *D. asper* was compared with the calyces of *D. lanceolata* Roxburgh, from India, and with a fossil, *D. rugosa* Saporta, from the Oligocene of southeastern France, the comparisons upon closer inspection fail to be convincing. The rugosity of the living and fossil species cited consists chiefly of cross-wrinkles or striae and not of papillae. No living species of *Diospyros*, so far as I am aware, has calyces with papillose rugosity. On the other hand, the fossils can be matched very well with the 4-parted burs of *Fagus*.

Associated with these likely burs of *Fagus* are leaves hitherto called *Dryophyllum tennesseensis* Berry. There seems to be no doubt that these leaves belong to the Fagaceae, but they are sufficiently different from those of living species of *Fagus* to arouse caution before assigning them to that genus. The leaves, moreover, have been found abundantly at other localities where no burs of *Fagus* have yet been taken. Consequently, more exploration seems indicated before a conclusion can be reached as to the organic relationship of the leaves and burs.

Occurrence.—On Mill Creek, Hardeman County, Tenn.

Sassafras suspectum Brown, n. sp.

Sterculia wilcoxensis Berry, U. S. Geol. Survey Prof. Paper 156: 107, pl. 26; pl. 27, fig. 5 [not other references]. 1930.

The leaves referred to here, described and illustrated by Berry, despite general resemblances seem to me to differ in important respects from the remainder hitherto synonymized with *Sterculia wilcoxensis*. The latter have wide, open sinuses between the relatively narrow, pointed lobes, and the midveins of the lateral lobes display a tendency to spread away from rather than to converge toward the apex. I can match the former easily by leaves from *Sassafras;* but I know of no living leaves that compare readily with the latter. If these also are *Sassafras* they should be kept distinct from the former.

These leaves are somewhat larger than those of the Tertiary species described from the northwestern States. In general appearance they also resemble some leaves of *Artocarpus pungens* (Lesquereux) Hollick, but the lobes of the latter are sharp-pointed.

Occurrence.—Railroad cut at Pine Top, Hardeman County, Tenn.

Staphylea splendens (Berry) Brown, n. comb.

Euonymus splendens Berry, U. S. Geol. Survey Prof. Paper 91: 267, pl. 61, fig. 6; pl. 62, figs. 1–5. 1916.

Hicoria crescentia Knowlton. Berry, U. S. Geol. Survey Prof. Paper 156: 59, pl. 34, figs. 1–5. 1930.

The first specimens described as *Euonymus splendens* were single detached leaves which aroused no suspicions of their being leaflets, although the describer noted that they were slightly inequilateral and bore some resemblance to *Hicoria antiquorum* (Newberry) Knowlton. In 1930, Berry reported compound leaves from Somerville, Tenn., as *Hicoria crescentia* Knowlton, on the basis of resemblance to a very fragmentary specimen described by Knowlton from Eocene strata in Yellowstone National Park. Whether Knowlton's specimen was correctly identified even generically is a moot question, but the leaflets of the Berry specimens of both species, as may be seen by comparing the illustrations, resemble one another so closely that I venture to believe they represent but one species.

In 1937 I visited Grand Junction and Somerville, Tenn., the chief localities from which the Berry specimens came and made collections containing additional material which convinces me that these specimens need reallocation. The outstanding facts about the compound leaves are that all are trifoliate, and all the leaflets have relatively long petiolules. Neither of these facts harmonizes with the assignment of the leaves to *Euonymus* or *Hicoria*, but they are consonant with an interpretation as *Staphylea*.

Unfortunately, none of the characteristic bladdery pods of *Staphylea* has yet been found in the Tennessee localities to confirm this identification. Collectors should be on the alert for them.

This species resembles closely *Staphylea acuminata* Lesquereux (1878, p. 267, pl. 48, figs. 4, 5) from the lake beds at Florissant, Colo., but in the Florissant specimens the petiolules of the side leaflets are very short, thus harmonizing more closely with the existing species, *S. trifolia* Linnaeus, of the eastern United States.

In general form, venation, and marginal dentition these leaves are similar to some called *Euonymus glandiferus* Ball (1931, p. 85, pl. 6, figs. 1, 2, 4; pl. 7, fig. 1) from the Indio formation of Texas. The latter, however, differ uniquely in having prominent glands in the angles made by the secondary veins with the midvein and about 5 mm from the midvein. At present I have no opinion as to the propriety of assigning the Indio specimens to *Euonymus*.

Occurrence.—One mile north of Somerville, Fayette County, Tenn.; one mile south of Grand Junction, Hardeman County, Tenn.

REFERENCES

Bailey, I. W., and Sinnott, E. W. *A botanical index of Cretaceous and Tertiary climates.* Science, n. ser., **41**: 831–834. 1915.

Ball, O. M. *A contribution to the paleobotany of the Eocene of Texas. 1.* Bull. Agr. and Mech. College Texas, ser. 4, **2** (5). 1931.

———. *Ibid. 2.* Bull. Agr. and Mech. College Texas, ser. 4, **10** (3). 1939.

Berry, E. W. *The lower Eocene floras of southeastern North America.* U. S. Geol. Survey Prof. Paper 91. 1916.

———. *Additions to the flora of the Wilcox group.* U. S. Geol. Survey Prof. Paper 131: 1–21. 1922.

———. *Revision of the lower Eocene Wilcox flora of the southeastern States.* U. S. Geol. Survey Prof. Paper 156. 1930.

———. *Additions to the Wilcox flora from Kentucky and Texas.* U. S. Geol. Survey Prof. Paper 193: 83–99. 1941.

Brown, R. W. *New species and changes of name in some American fossil floras.* Journ. Washington Acad. Sci. **30**: 344–356. 1940.

Cain, S. R. *The Tertiary character of the cove hardwood forests of the Great Smoky Mountains National Park.* Torrey Bot. Club Bull. **70**: 213–235. 1943.

Lesquereux, Leo. *The Tertiary flora.* U. S. Geol. Survey Terr. Rept. **7**. 1878.